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DEPARTMENT OF MECHANICAL ENGINEERING

TITLE OF THESIS:	AN INVESTIGATION TO ENHANCE STRATIFICATION IN SOLAR DOMESTIC HOT WATER TANKS USING PHOTOVOLTAIC POWER
TIME/DATE:	10:00 am, Wednesday, August 14, 2019
PLACE:	Room 3107, The Mona Campbell Building, 1459 LeMarchant Street

EXAMINING COMMITTEE:

Dr. Simon Furbo, Department of Civil Engineering, Danish Technical University (External Examiner)

Dr. Ismet Ugursal, Department of Mechanical Engineering, Dalhousie University (Reader)

Dr. Timothy Little, Department of Electrical and Computer Engineering, Dalhousie University (Reader)

Dr. Peter Allen, Department of Mechanical Engineering, Dalhousie University (Supervisor)

DEPARTMENTAL REPRESENTATIVE:	Dr. Dominic Groulx, Department of Mechanical Engineering, Dalhousie University
CHAIR:	Dr. Lois Jackson, PhD Defence Panel, Faculty of Graduate Studies

ABSTRACT

Improved energy conservation methods and awareness of these methods in the industrial sector, along with the decreasing cost of photovoltaic (PV) technology, implicates PV-water heating system designs as economically sustainable alternatives to traditional methods for domestic hot water systems (DHWS). The proper design for an electric resistance immersion heater element in a thermo-syphon side-arm storage tank using PV power heating has not yet been determined. This research is an experimental investigation to evaluate the proper design of a thermo-syphon side-arm storage tank using PV-heating, with longitudinally perforated manifolds that work with standard Canadian domestic solar hot water tanks under different climate conditions in Halifax, Nova Scotia.

The evaluation of the performance of the hot water inlet devices was based on the assessments of flow visualization, temperature distributions inside the storage tank, degrees of stratification (DOS), availability, availability ratio, energy delivery, entropy ratio, merit factor and internal entropy generation. The most effective hot water inlet device is the one which has a high DOS, availability change, merit factor, energy delivery, and average availability ratio. Furthermore, it has a low entropy ratio and a low internal entropy generation.

The results of this testing indicated that using a four-port manifold in which the port diameter increases gradually from small at the bottom to large at the top is a workable solution to enhance stratification. Also, the four-port manifold has the highest degree of stratification, and a high change rate for the temperature of the top tank layers and responded earlier in the day than the traditional design for most of the experimental tests. This means the four-port manifold has the ability to enhance stratification. Furthermore, we found that it is difficult to use entropy ratios to determine the ability of hot water inlet devices to enhance stratification, because the entropy difference values were too small. Moreover, the normalized entropy ratio and internal entropy generation results were both greater than one, which are an unrealistic value. Due to this issue we cannot recognize these two parameters in our evaluations.